ISOCHROMATIC PHOTOGRAPHY

WITH CHLOROPHYL.

A REPRINT OF THE AUTHOR'S PRINCIPAL PUBLICATIONS RELATING TO THE SUBJECT OF CORRECT-COLOR-TONE PHOTOGRAPHY, WITH SOME NEW EXPLANATORY NOTES, EXTRACTS FROM VARIOUS OTHER PUBLICATIONS, AND A STATEMENT CONCERNING A DISCUSSION ABOUT PRIORITY.

BY

FREDERIC E. IVES.

PHILADELPHIA:

PRINTED BY THE AUTHOR.

1886.

Chlorophyl Process

Eosine Process.

Ordinary Process.

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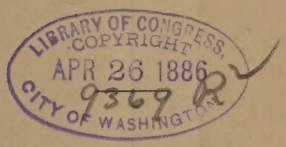

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PREFACE.

When, in 1879, the writer first called attention to the possibility of producing correct-color-tone photographs, and published a complete process of isochromatic photography with chlorophyl, the process was not tried, because the writer was then unknown, and nobody believed it possible to accomplish what he claimed. More recently, when it became generally known that such photographs were being made, and the correctness of the writer's claims was established, attention was diverted from the chlorophyl process by the discovery of means for producing red- and orange-sensitive gelatine dry plates, which it was believed would soon be made to give equally correct photographs, with very much shorter exposures, and without the necessity of preparing them immediately before use. Makers of gelatine dry plates privately advised photographers not to try the collodion color-sensitive processes, because they expected to soon supply dry plates which would be much more satisfactory. Another year has passed, and although some good work has been done with color-sensitive gelatine dry plates, no American manufacturer has yet placed them on the market, and, according to all accounts, their production is attended with extraordinary difficulties and uncertainties; nor does it appear to have been proved that the best of them are much superior in color-sensitiveness to the writer's perfected chlorophyl-eosine process, which offers

the advantage that it is immediately available to every practical photographer in the land.

A knowledge of these facts is now causing many photographers to seek to know more of the chlorophyl process; the collection of articles herewith reprinted will supply the desired information. The most important practical information for the working photographer will be found on pages 14–16, 18; but as a general knowledge of the subject will prove useful, all the first part of the book should be read carefully. Much matter which might otherwise have been thrown out, has been retained because of its historical value, and will serve to show the development of the process from the time chlorophyl was first used for the purpose of making correct-color-tone photographs.

The writer wishes to have it clearly understood that while his processes will give as perfect results as any, he does not doubt that red-sensitive gelatine dry-plates, if sufficiently good and reliable ones shall be placed on the market, will offer important advantages for some purposes,—especially for use by amateurs who do not prepare their own plates and are not practically familiar with the collodion processes, and for landscape photography. But he believes that his process with chlorophyl also possesses peculiar merits which make it distinctly the best for some purposes.

In order to make it convenient for photographers to try the process, the writer will undertake to supply, at a reasonable price, sample lots of the bromide emulsion, and suitable color-screens. Photographers who make their own emulsion are requested to see that it works clear by itself, before trying it with chlorophyl; an emulsion may fog when new, but work clear when a few days old. F. E. I.

Philadelphia, April 15, 1886.

ISOCHROMATIC PHOTOGRAPHY WITH CHLOROPHYL.

PART I.—F. E. IVES' ORIGINAL PUBLICATIONS.

ON PHOTOGRAPHING COLORS.

[THE FIRST PUBLISHED PROCESS OF PHOTOGRAPHING ALL COLORS CORRECTLY.]

From The Philadelphia Photographer, December, 1879.

Every photographer is acquainted with the fact that colors which look light will often photograph dark, while some colors that look dark, photograph light. But I believe very few are aware of the fact that it is quite possible and practicable to overcome this difficulty where short exposures are not essential. Such a method is very valuable for copying oil paintings, and I use it to great advantage in making negatives of highly colored prints and objects for photographs on wood, where it is important that the details be very fine throughout.

Negatives of natural scenery, made in this way, are indescribably beautiful; the details develop richly throughout everything, whatever the color.

Hoping it may prove useful to others as it does to myself, I will describe the method which I have perfected.

I place the object to be photographed in a strong light if possible, and use a quick-working objective, directly in front of which is placed a lantern-tank, having thin plate-glass sides nearly half an inch apart. Fill the tank with a solution of bichromate of potash, 1 part bichromate to 1,000 parts water. Focus as usual; then prepare a plate with *Newton's Emulsion* (I always manufacture it myself, and find it uniform and perfectly reliable,) as follows:

As soon as the emulsion is set, pour upon it a little alcoholic solution of *chlorophyl* (formula below), and flow backwards and forwards for about thirty seconds, after which wash until smooth. Flow with tea organifier (tea ½ ounce, water 10 ounces,) rinse, and expose

about two and a half times as long as is required with the plain emulsion without tank of yellow.

Develop with the sal-soda developer (I make this double the strength recommended by Mr. Newton, and dilute where over-exposure is suspected.) If the bichromate of potash solution is too intense, blue and green will photograph too dark; if it is too weak, red will photograph too dark. I have given the proportions I find perfectly adapted to my tank, lens, and chemicals.

To prepare the chlorophyl, first extract everything soluble in water from myrtle or tea leaves, by treating with a number of changes of hot water. Then dry the leaves, and the chlorophyl may be extracted at any time by treating about an ounce of leaves with four ounces of hot alcohol.

Myrtle leaves yield the most chlorophyl, the solution of which should be of a deep, pure green color, and will remain good a long while *if kept in the dark*. It spoils very soon if exposed to a strong light.

In making Newton's emulsion, I find it advantageous to mix it in the morning. Try a plate once each hour after, and add the chloride as soon as it fogs, which is sometimes within three hours. The emulsion will then be good at once, and remain so. Be careful to give full exposure. Better over- than under-expose, and judicious development will make perfect.

The lantern tank which I use is a "sciopticon-tank," made to order with plate-glass sides; it cost $1.25. Nothing could be better.

I have made two negatives from a highly colored chromo-lithograph, one by the usual method, the other by the method described above. The difference is wonderful. The effect in the first is hard and unsatisfactory, the gradations of light and shade all wrong. The second is remarkably soft, delicate, and brilliant; the colors photograph harmoniously, and not a detail is lost. The value of this method for making copies of oil paintings will be readily appreciated.

FRED. E. IVES.

EOSINE AND OTHER STAINED PLATES.

From The Photographic News, Nov. 23, 1883.

It may interest you to know of my experience with *eosine* as a sensitizer of silver bromide for yellow light. I have used it only with collodio-bromide plates, but with great success. I believe that the action of the eosine is purely chemical, and that nothing depends upon the *coloration* of the film. I found that the application of a

very dilute solution was best, but that even then the sensitiveness (to yellow) was enormously increased by carefully washing out as much as possible after it had had time to act on the silver bromide. I applied the eosine solution (simple solution in water) after the plate was coated and washed, then washed again to get rid of color. A curious fact is that these plates showed no sensitiveness to yellow light when developed with the alkaline pyro. developer, unless there was present a little free silver nitrate.* With oxalate [of iron] development the presence of silver nitrate was unnecessary and undesirable. I used the plates immediately after their preparation, without drying.

A much better color sensitizer (when it can be obtained) is a fresh alcoholic solution of *chlorophyl* from *fresh blue-myrtle leaves.* It should be applied as soon as the emulsion (collodion) is set, flowed backward and forward for thirty seconds, then the plate washed in water until smooth, when it is ready for exposure.

These plates are quite sensitive to every color which can be distinguished by the eye, including the deepest ruby red. By means of these plates and colored screens I have secured results which you would probably have thought it impossible to secure by any photographic process. I have not been able to secure a chlorophyl solution which would give the same results from any other leaves than those mentioned—"blue-myrtle;" and both leaves and solution must be fresh to secure the greatest degree of sensitiveness. I do not see how it will be possible to employ chlorophyl successfully with gelatine plates.† FRED. E. IVES.

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*[This is true only of eosine plates prepared exactly as here indicated. If there be present any free eosine, it will act much like a trace of silver, to make the color-sensitiveness manifest itself with alkaline pyro. development, but with this important difference, that the trace of silver acts far more powerfully and perfectly than the free eosine. The plates prepared by washing out the free eosine and then adding a mere trace of silver nitrate are as sensitive, and will give as good results, as those prepared by the "wet eosine process" which Dr. Vogel published in the year following. *The procedure may be varied by dipping the washed eosine plates into an ordinary negative silver bath before exposure, and developing with the usual bath plate developer.* Plates prepared with eosine in this manner are considerably more sensitive to yellow-green than chlorophyl plates prepared with an *old solution* of chlorophyl; they are therefore very useful under some circumstances,—as when fresh chlorophyl cannot be obtained, and red-sensitiveness is not required. They are very much cheaper, and for many purposes better, than the yellow-sensitive gelatine dry plates now in the market.]

†[In December, 1885, I succeeded in making gelatine dry plates color-sensitive by treatment with chlorophyl. Carbutt's B plates were soaked in water one minute, drained, backs wiped dry, then immersed in the alcoholic solution of

ISOCHROMATIC PLATES BY MEANS OF CHLOROPHYL.

From The Photographic News, Sept. 5, 1884.

My method of preparing chlorophyl solution and using it for increasing the color-sensitiveness of silver bromide plates, was published nearly five years ago in the *Philadelphia Photographer*; but in answer to your request, I furnish the following particulars for publication in the *News*.

Take fresh blue-myrtle leaves, cut them up into very small bits, and place in a florence flask. Cover with alcohol, and warm over a spirit lamp for about twenty minutes, stirring constantly, and taking care not to heat too hot, which might destroy some of the chlorophyl. The solution will be of a deep rich green color, and will keep some weeks if tightly corked, and not exposed to light. It may also be prepared from the dried leaves by first soaking them in distilled water, but is not so good as that from the fresh leaves, and in either case a fresh solution will give the best results. I have been told that the addition of a little powdered zinc to the solution will cause it to retain its strength indefinitely, but I have not yet tried the experiment.

I believe that any good collodio-bromide emulsion will answer, but I have always used one made with a slight excess of nitrate of silver, which was afterwards converted into chloride of silver.

The plates are prepared by first flowing with the emulsion, then, as soon as it is set, covering with the chlorophyl solution for one minute. They are then washed thoroughly with pure water, and exposed in the camera while still wet, using a colored screen in front of the lens to filter out light which would otherwise produce too much effect. As long exposures are necessary, it is often an advantage to flow the plate with glycerine, and the object to be photographed should be placed in direct sunlight, when practicable.

The best screen for filtering the light is a small plate-glass tank containing a solution of bichromate of potash. If the tank is three-eighths inch between the glass, the bichromate solution may be of the strength of one grain of bichromate of potash to two ounces of water. If stronger, blues will photograph too dark, and yellow and red too light; if weaker, blues will be too light, and yellow and red too dark. If a solution of aniline red is used as a screen, the red and yellow of

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chlorophyl two minutes. When these plates were exposed immediately after their preparation, through a *deep orange* screen, good results were obtained,—but not so good as with the collodion emulsion plates. Within a few hours after their preparation, every trace of color-sensitiveness disappeared.]

a highly colored chromo-lithograph can be made to photograph almost like white, while blue comes out black. With a green screen of a certain shade and intensity [chlorophyl solution,] I have made bright chromo-lithographs photograph as if almost all of the color had been bleached out of them.

Something depends also upon the developer, some developers bringing out the color-sensitiveness more than others, or in different proportions; but so far as my experience goes, this difference is not nearly so marked with chlorophyl as with eosine plates.

It has been stated that isochromatic plates do not give a sensibly different effect from others in photographing landscapes, but this is true only when no colored screen is employed. Some of the most striking results I have obtained were landscape photographs made with the chlorophyl plates. The effect is not only different, but so very different that everyone who sees them is astonished. I will send you prints from three negatives which were made simultaneously, one with chlorophyl and a red screen, one with eosine and a yellow screen, and one with plain emulsion and no screen. Had I used the chlorophyl plate with a yellow screen, it would have given nearly the same result as the eosine, except that reds would have developed stronger; but had I used the eosine plate with the red screen, it would have given no image whatever.

I have experimented with the addition of both chlorophyl and eosine to the emulsion, but have not secured one-half as good results in that way as by applying them in the manner which I have described.

FRED. E. IVES.

ISOCHROMATIC PLATES WITH CHLOROPHYL.

From The Year-Book of Photography for 1885.

The method of isochromatic photography which I published in 1879, was so great a step in advance of anything then known, that my claims were regarded as too improbable to merit respectful consideration, and I could not persuade anyone to give the method a fair trial. Writers continued to lament that "it was impossible," etc., and it was not until early in the present year, when Dr. Vogel claimed that he had just discovered the first and only completely successful method, that considerable attention was given to this line of research. Dr. Vogel was undoubtedly the first to suggest the use of dyes for increasing the color-sensitiveness of silver-bromide, but he was not the first by several years to publish a practically useful process,

nor has he, or anyone else, ever published one equally as successful and valuable as that which I published in 1879.

After testing the recently-published processes, I once more called attention to my method in the *Photographic News*, Sept. 5, 1884; and in order that its value may be readily appreciated I now contribute to the *Year-Book* two photo-typographic prints illustrating its remarkable capabilities. The subject selected is a highly-colored chromo-lithograph of a lady wearing a bright-scarlet hat with purple feather, a yellow-brown cape, and a dark-blue dress. Having used a deeper yellow screen than was necessary, I have exaggerated the effect so that there can remain no doubt whatever of the capability of the process to bring out the full values of all those colors which photograph too dark by the ordinary methods.

A characteristic of my process, which distinguishes it from all others, is the great sensitiveness of the plates to every part of the visible spectrum, which makes it possible to secure an almost endless variety of effects by simply changing the color and intensity of the screens.

The process consists of treating collodio-bromide emulsion plates with the chlorophyl of "blue-myrtle" leaves to render them sensitive to all colors, then placing a yellow screen in front of the lens to cut off part of the blue and violet light.

To prepare the chlorophyl, cut the leaves up fine, and cover with pure alcohol, heating moderately hot for a few minutes. It is most sensitive when fresh, but will keep good for some weeks in a cool place, protected from light. The leaves should be left in the solution, and the addition of a little powdered zinc appears to have a beneficial effect.

To prepare the plates, flow with collodio-bromide emulsion, and when set, cover for a few seconds with the chlorophyl solution, after which wash in distilled water until smooth. Great care must be taken to protect them from light during and after preparation.

In front of the lens place a small tank having plate glass sides, and filled with a solution of bichromate of potash. If the space between the sides of the tank measures three-eights of an inch, the bichromate solution may be of the strength of one grain to two ounces of water. If yellow and red photograph too light, the yellow solution should be made weaker.

Expose two or three times as long as would be necessary if there were no colored screen, and develop with alkaline pyro. developer. If the plates veil, add more bromide to the developer, and use less light in the dark-room. In very warm weather the plates may not

work perfectly clear unless the chlorophyl solution is made a few days before the plates are prepared. FRED. E. IVES.

ISOCHROMATIC PHOTOGRAPHY.

Read at meeting of Franklin Institute, March 18, 1885.
Published in Franklin Institute Journal, May, 1885.

It is well known that the ordinary photographic processes do not reproduce colors in the true proportion of their brightness. Violet and blue photograph too light; green, yellow, orange and red, too dark. For a long time it was believed to be impossible to remedy this defect; and even when it became known that bromide of silver could be made more sensitive to yellow and red by staining it with certain dyes, the subject received very little attention, because it was also known that the increase of sensitiveness was too slight to be of practical value in commercial photography.

Dr. H. W. Vogel, who was one of the first, though not the first, to devote attention to this subject, announced, in 1873, that he had succeeded in making a yellow object photograph lighter than a blue or violet one, by using a silver-bromide plate stained with coraline, and exposed through a yellow glass. The plate showed no increased sensitiveness to red, and the experiment, although of considerable scientific interest, did not indicate a practically useful process.

In the spring of 1878 I became interested in this subject, and tried to discover a method of producing plates which should be sensitive to all colors, and capable of reproducing them in the true proportion of their brightness. I commenced by trying nearly all the color-sensitizers which had already been suggested, in order to learn which was the best, and then, if possible, *why* it was the best, as a guide to further research. Chlorophyl was the only thing I tried which was sufficiently sensitive to red to offer any encouragement in that direction; but the solution which I obtained was weak and unstable, and far from being a satisfactory color-sensitizer. Hoping to obtain a better solution with which to continue my experiments, I made extracts from many kinds of leaves, and found that a solution from blue-myrtle leaves looked better and kept better than any other, and when it was applied to the silver-bromide plates they became remarkably sensitive, not only to all shades of red, but also to orange, yellow and green. By placing in front of the lens a color-screen consisting of a small glass tank containing a weak solution of bichromate of potash, to cut off part of the blue and violet light, I obtained, with these

chlorophyl plates, the first photographs in which all colors were reproduced in the true proportions of their brightness. But my chief desire at that time was to realize a method of producing from any object in colors a set of three negatives, in one of which the shadows should represent the blue of the original, in another the yellow, and in another the red, in such a manner that transparent pigment prints from these negatives—blue, yellow and red—would, when superimposed on a white surface, represent not only the lights and shadows, but also the colors of the object. This had already been attempted by others, who failed because their plates were not sufficiently sensitive to red and yellow.

Having succeeded perfectly in my undertakings, I published my discovery in 1879,* explaining how to prepare and use the chlorophyl plates, in connection with the yellow screen, for the purpose of securing correct photographs of colored objects.†

So far as I know, nobody tried the process. Nearly five years later Dr. Vogel announced that, after eleven years of investigation, he had at last realized a successful process of this character, and that this new process of his, was the "solution of a problem that had long been encompassed with difficulty." This publication attracted a great deal of attention, and gave me occasion to again call attention to my process,‡ and point out that it was not only the first practical solution of this problem, but the only truly isochromatic [correct-color-tone] process ever discovered. Dr. Vogel's new process was not only no better in any respect, but the plates were insensitive to scarlet and ruby-red, and therefore would not photograph all colors in the true proportion of their brightness.

My method consists in treating ordinary collodio-bromide emulsion plates with blue-myrtle chlorophyl solution, exposing them through the yellow screen, and then developing them in the usual

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* *Philadelphia Photographer*, December, 1879, p. 365.

† I intended this publication to be a very full and explicit one, and it was sufficiently so to be perfectly understood by most who saw saw it; but some may think I did not sufficiently emphasize the importance of using the particular kind of chlorophyl which I mentioned. In a brief communication to the editor of the *Photo. News*, in 1883, I described some experiments with eosine as a color-sensitizer, and then called attention to the superiority of blue-myrtle chlorophyl for this purpose, stating that I had not been able to secure such results with any other kind of chlorophyl, and that a fresh solution from fresh leaves must be used to secure the greatest possible degree of sensitiveness. See *Photo. News*, Nov. 1883, p. 747.

‡ *Photo. News*, London, Sept. 5, 1884, p. 566, and *Year-Book of Photography* for 1885, p. 111.

manner. The emulsion which I have employed is made with an excess of nitrate of silver, which is afterwards neutralized by the addition of chloride of cobalt; it is known as Newton's emulsion. I now prepare the chlorophyl from fresh blue-myrtle leaves, by cutting them up fine, covering with pure alcohol, and heating moderately hot; the leaves are left in the solution, and some zinc powder is added, which helps to keep the chlorophyl from spoiling. I have a bottle of this solution which was prepared about six months ago, and now appears to be as good as when first made.* A glass plate is flowed with the emulsion, and as soon as it has set, the chlorophyl solution is applied for a few seconds, after which the plate is washed in pure water until smooth, when it is ready for exposure.

My color-screen consists of a small plate-glass tank, having a space of three-sixteenths of an inch between the glass, filled with a solution of bichromate of potash about one grain strong. I place the tank in front of the lens, in contact with the lens-mount. The advantage of this tank and solution is that it can be more easily obtained than yellow plate glass, and the color can be adjusted to meet any requirement.

The plates require about three times as much exposure through the yellow screen as without it,† and may be developed with the ordinary alkaline pyro. developer.

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* I originally recommended chlorophyl extracted from dried leaves, because I had not yet learned how to preserve the solution for more than a few weeks,—and at some seasons it would be difficult, if not impossible, to obtain fresh leaves. The tea organifier which I recommended is also a color-sensitizer, and when it is used in connection with the chlorophyl from dried leaves the plates are as sensitive as can be safely prepared and developed in the light of an ordinary photographic "dark-room." Plates prepared with chlorophyl from fresh leaves do not require treatment with the tea organifier to secure this degree of sensitiveness. Recently I have used the tea organifier and some other sensitizers in connection with the solution from *fresh* myrtle-leaves, and in this way have produced plates having such an exalted color-sensitiveness as to be unmanageable in ordinary "dark-room" light. Possibly, such plates might be prepared and developed in total darkness, by the aid of suitable mechanical contrivances, but I am not sure that they would work clear even then, because they appear to be sensitive to heat as well as to light. [Previous to the publication of the foregoing note, all of my experiments were conducted in dark-rooms which were quite unsuitable for the purpose, because the orange and ruby glass windows freely transmitted the red light to which chlorophyl plates are sensitive. The extra-sensitive plates mentioned were prepared with fresh chlorophyl, eosine and tea organifier, and such plates can be safely prepared and developed in a special light, as I explained in a later publication.]

† [The reader will please note that I nowhere compared the sensitiveness of

In order to illustrate the value of this process, I made two photographs of a highly-colored chromo-lithograph representing a lady with a bright scarlet hat and purple feather, a yellow-brown cape and a dark-blue dress. One, by the ordinary process, represents the blue as lighter than the yellow-brown, the bright scarlet hat as black, and the purple feather as nearly white. The other, by the chlorophyl process, reproduces all the colors in nearly the true proportion of their brightness, but with a slight exaggeration of contrast produced purposely by using a too-strong color-solution in the small tank.

I also made two landscape photographs, one by the ordinary process, and the other by the chlorophyl process, exposing them simultaneously. In the ordinary photograph, distant hills are lost through over-exposure, yet the foreground seems under-exposed, and yellow straw stacks and bright autumn leaves appear black. In the chlorophyl photograph, the distant hills are not over-exposed, nor is the foreground under-exposed; the yellow straw stacks appear nearly white, and bright autumn leaves contrast strongly with the dark green about them.

To test the relative color-sensitiveness of plain emulsion plates, plates stained with eosine, and plates stained with the blue-myrtle chlorophyl, I exposed one of each kind through the same yellow screen, giving each five minutes' exposure, on the same piece of copy, which was the chromo-lithograph already described. The plain emulsion plate showed only the high-lights of the picture, after prolonged development. The eosine plate was under-exposed, but brought up everything fairly well except the scarlet hat, which came up like black. The chlorophyl plate was over-exposed, brought out all colors better than the eosine plate, and gave full value to the bright scarlet of the hat, the detail in which was beautifully rendered.*

Dr. Vogel advanced the theory that silver-bromide is insensitive to yellow and red, because it reflects or transmits those colors; and

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this process with that of the ordinary bath process, but merely indicated the relative exposure for the same *chlorophyl* plates with and without the color screen. In photographing an object illuminated with direct sunlight, the collodion silver-bromide plates prepared with fresh myrtle-chlorophyl alone, require about ten times as much exposure through the yellow screen as an ordinary bath plate without the screen; but in diffused daylight the difference is very much greater.]

*[The chlorophyl plate was prepared with a fresh solution of chlorophyl from fresh young myrtle-leaves. If the chlorophyl solution had been a few days old, or had been made from washed and dried leaves, or even from fresh leaves picked late in the fall of the year, the plate would have required *more* exposure than an eosine plate, to bring out the yellow, green and blue portions of the picture.]

that it becomes sensitive when stained, because of the optical properties of the dyes. He afterwards admitted that only such dyes as are capable of entering into chemical combination with the silver-bromide proved capable of increasing its sensitiveness to color, but he held to the theory that the optical properties of the compound were the cause of its color-sensitiveness.

I have shown that the color-sensitiveness can be produced by treatment with an organic compound which has none of the optical properties characteristic of dyes; and that chlorophyl, which absorbs only red light,* greatly increases the sensitiveness also to yellow and green. There is, therefore, good reason to doubt if the color-sensitiveness is ever due to the optical properties of the dye or combination.

Attempts have been made to produce isochromatic gelatine dry plates which, while many times more sensitive to white light than my chlorophyl plates, shall also show the *same relative* color-sensitiveness. Such plates would be very valuable but for one fact: it would be necessary to prepare and develope them in almost total darkness. Gelatine bromide dry plates extremely sensitive to yellow, but *comparatively insensitive to red*, might be used to advantage in portrait and instantaneous photography, because they could be safely prepared and developed in red light; but when truly isochromatic [*all*-colors-correct] photographs are required, the time of exposure must be regulated to suit the degree of sensitiveness to red, which cannot safely [in ordinary dark-room light] be made greater than I have realized with my chlorophyl process. FRED. E. IVES.

ISOCHROMATIC PHOTOGRAPHY.

Read at meeting of Franklin Institute, May 19, 1885.

Published in Franklin Institute Journal, July, 1885.

For the purpose of better illustrating the capabilities of my process of Isochromatic Photography, I have recently made a large number of photographs of a color-scale, which is made up of pieces of woolen cloth, dyed red, scarlet, yellow, green, blue, violet, magenta, etc. The exposures were made through color-screens, which were carefully selected by the aid of the spectroscope, in order that it might be known in each case what kind of light was transmitted.

I have not had time to make a set of lantern positives, but will

* [Chlorophyl shows three feeble absorption *striæ* in the orange-yellow and green, a deep black band in the red.]

show some of the negatives on the screen, and also one positive, made from prints which have been arranged for comparison.

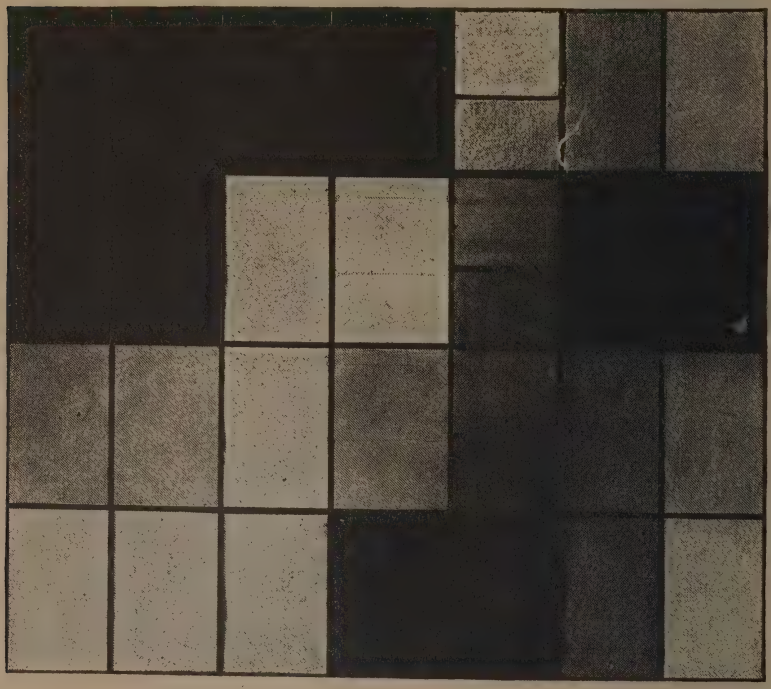
The first negative is an ordinary photograph of the color-scale, in which blue, violet and magenta are the only colors which photograph with considerable intensity.

The second photograph was made with an eosine-stained plate, exposed through a yellow screen. Light-blue, green, yellow and light yellow-brown are the only colors which photograph well.

The third photograph is by my isochromatic process, and all of the colors come up in approximately the true proportions of their brightness.

The fourth is one of my chlorophyl plates exposed through a scarlet screen, and brings out with remarkable intensity all those colors which have usually been regarded as non-actinic; but green and blue come out like black.

Red. Scarlet. Yellow. Green. Blue. Violet. Magenta.



In the lantern positive, seven squares are shown from each negative, arranged for comparison. The first row is from the ordinary

photograph, the second is from the eosine plate exposed through a yellow screen, the third is from the isochromatic [correct-color-tone] photograph, and the third is from the chlorophyl plate exposed through the scarlet screen. These photographs tell their own story so far as regards the capacity of the processes; but my investigations have revealed some remarkable facts, which I will now state briefly, without entering further into the details of my experiments.

1. Although collodio-bromide emulsion plates, stained with blue-myrtle chlorophyl alone are capable of photographing all colored objects in the true proportions of their brightness, they are far more sensitive to the extreme dark-red of the spectrum, below the absorption band of chlorophyl, than to either the orange, yellow or green.

2. All red, orange and yellow objects reflect the dark-red light to which chlorophyl plates are so sensitive, and bright yellow objects reflect as much of this light as red ones. Yellow objects photograph lighter than red ones by this process, because they reflect two kinds of light to which the plates are sensitive, while red objects reflect only the one kind.

3. The sensitiveness of the chlorophyl plates to spectrum yellow and green may be greatly increased by treating them with the tea organifier, which also nearly doubles the general sensitiveness, but without appearing to alter the effect in photographs made through a yellow screen. If a green screen is used, of a shade which does not transmit the dark red of the spectrum, the resulting photograph is better when the tea organifier has been used, and does not then differ from one made by exposing an eosine-stained plate through the same screen.

4. The dark-red of the spectrum passes freely through a solution of chlorophyl, and through ruby and orange glass, but is absorbed by common green glass, and by solutions of sulphate of copper and Prussian blue.

These facts show that plates prepared with both sensitizers, according to my original instructions, are, strictly speaking, more nearly isochromatic than those prepared with chlorophyl alone; but that in the production of photographs of colored objects they seldom offer any practical advantage, except that of reducing the exposure about one-half, at the expense of some extra labor and care in their preparation and development.

It is also evident that the safest light in which to prepare and develop chlorophyl plates is neither ruby nor orange. The light which I find most suitable for this purpose is that transmitted by a combination of two thicknesses of deep orange glass with one of green.

FRED. E. IVES.

ISOCHROMATIC PHOTOGRAPHY.

From Anthony's Photographic Bulletin, July 11, 1885.

In response to your invitation, I now give the following additional particulars of my process of Isochromatic Photography, a brief description of which you have reprinted from the *Journal of the Franklin Institute.*

The collodion emulsion with which the plates are prepared is made as follows:

Material for 20 ounces—

Alcohol,	10 oz.
Ether,	10 oz.
Bromide of Cadmium,	220 gr.
Anthony's Green Label Cotton,	120 gr.
Nitrate of Silver,	300 gr.

Dissolve the bromide of cadmium in five ounces of the alcohol, then add the cotton and shake well. Add all the ether, then shake again until all the cotton is dissolved.

Grind the nitrate of silver in a glass mortar, and put it in a florence flask. Pour a small portion of the remaining five ounces of alcohol on the silver, and heat over an alcohol lamp (stirring briskly) until the alcohol is saturated with silver. Pour the silver solution into the collodion (do this in the dark room), and shake briskly for two minutes. Repeat the operation until all of the silver is in the collodion; then add the remainder of the alcohol, and proceed to test for free silver.

Pour a little of the emulsion on a glass, take it into white light, and put on a drop of a solution of bichromate of potash, which will produce a blood-red stain if the emulsion contains sufficient silver. The excess must then be neutralized by adding to the emulsion sufficient of a strong alcoholic solution of chloride of cobalt. Add a little at a time, until the bichromate test no longer produces a red stain, when the emulsion will be right. It should be kept in an amber-glass bottle, in a light-tight box in the dark-room. It will be fit to use the day after it is made, and will keep indefinitely. It should be shaken up about an hour before using.

The chlorophyl solution is made by cutting up fresh blue-myrtle leaves, covering them with pure alcohol, and heating moderately hot. If it is desired to make a solution that will keep well, some powdered zinc or zinc shavings should be put in with the myrtle leaves before heating to extract the chlorophyl. Both leaves and zinc should be

left in the solution, and the bottle kept in a light-tight box. I have a bottle of this chlorophyl solution which is nearly a year old, and still works well, but the plates prepared with it require three or four times as much exposure as those prepared with a solution not more than forty-eight hours old. As the plates are comparatively insensitive at their best, a fresh chlorophyl solution should be used whenever it can be obtained.

Recently, I have found some other leaves that yield chlorophyl equal to the blue-myrtle; but solutions from most kinds of leaves are not satisfactory.

To prepare the plates, flow with the emulsion, and when set cover for a few seconds with the chlorophyl solution, after which wash in running water until smooth. If it is desired to still further increase the sensitiveness, the plates may be placed in an infusion of black tea for a minute or two, and then washed again very thoroughly. These plates must be exposed while wet, and if more than ten minutes' exposure will be required, they should be flowed with glycerine, which will keep them moist for hours, without in any way injuriously affecting them.

A yellow screen for cutting off part of the blue and violet light must be placed in front [or back] of the lens, in contact with the lens mount. I now use films of gelatine colored with picric acid, and mounted with Canada balsam between two carefully selected pieces of thin plate glass; but, as it would not be easy for an inexperienced person to prepare a perfect color-screen of this description, I recommend the lantern tank and weak solution of bichromate of potash, which I have already described.

With a color-screen of suitable intensity, and a rapid rectilinear lens, an exposure of one to ten minutes is sufficient to make a perfect negative of an oil painting in direct sunlight. The alkaline pyro. developer may be used, with sufficient bromide to prevent fog.

FRED. E. IVES.

ISOCHROMATIC PHOTOGRAPHY.

From The British Journal of Photography, Aug. 14, 1885.

To the Editors: It may interest your readers to know that I have improved my process of isochromatic photography, by using alcohol which is tinted with eosine for making up the chlorophyl solution. It is a remarkable fact that the presence of a trace of eosine, when applied with the chlorophyl in this manner, not only produces

more yellow and green sensitiveness, but at the same time makes the plates more sensitive to the red pigments. . . . Plates prepared with the chlorophyl-eosine solution and tea organifier (three color-sensitizers), give me perfect photographs of difficult oil paintings with exposures of a minute and less.

FRED. E. IVES.

ISOCHROMATIC PHOTOGRAPHY WITH CHLOROPHYL.

PART II.—MISCELLANEOUS PUBLICATIONS, AND A STATEMENT RELATING TO CLAIMS TO PRIORITY.

FROM ANTHONY'S PHOTOGRAPHIC BULLETIN, OCT. 10, 1885.

"Without going into the question of who first had the idea of making all the colors register their true gradation of light and shade upon the photographic plate, it certainly remains clear that Mr. Fred. E. Ives, of Philadelphia, was the first to realize and practically carry out a process to effect the object in view. His method of doing this has already been described in the pages of the *Bulletin*.

. . . . . .

"As will be seen by referring to Mr. Ives' original papers in the *Bulletin*, he makes the photographic plate sensitive to red and yellow light by adding chlorophyl, the green coloring matter of blue-myrtle leaves, to the film. In Europe, on the other hand, Dr. Vogel uses a material which he calls azaline; while Schuman, Eder and others use eosine, cyanin and other dye-stuffs. In all these cases—Ives' as well as the others—a screen of yellow color interposed between the object and the sensitive plate is used to moderate the action of the blue and violet rays. And Ives' plates must be developed in subdued deep orange-green light.

. . . . . .

"In all the processes, the examples of which we have noted above, we do not find the fine gradations of shade in all the colors which is to be noted in the examples that we have of the Ives' chlorophyl process. In a picture of an autumn landscape that we have before us, the contrast between the two photographs of it—the ordinary and the orthochromatic—is really wonderful. In the ordinary photograph the richly colored foliage is one uniform mass of blackness, while in the orthochromatic photograph the lights and shades are beautifully

preserved. In another example we have two photographs of a bank note, in which at first sight it would appear that two different notes had been photographed; while, on the contrary, the difference is caused by the inability of the ordinary photograph to reproduce the yellow and blue parts of the note in their correct value, and the faithful reproduction of these by the Ives' process."

FROM THE SCIENTIFIC AMERICAN, NOV. 7, 1885.

"No better proof of the failure of ordinary gelatine dry plates to accurately register the varying intensity of different colors is found than when one attempts to copy a brilliant oil painting or a chromo. Improvements in this direction are always interesting, and to Mr. Fred. E. Ives, of Philadelphia, inventor of the Ives phototype process, belongs the credit of the development of chlorophyl as a sensitizing medium.

"We were recently shown a few comparative specimens made by this process, which were remarkable for their softness and the brilliancy with which ordinary non-actinic colors, such as red and yellow, were brought out. Under each orthochromatic photograph was mounted an ordinary one. One of the drawbacks of the process is that the solution has to be freshly prepared shortly before use, and the exposure necessary is unusually long.

"In explanation of the specimens shown us, Mr. Ives states that a wide-angle rectilinear lens with the largest stop was used. The exposure was five minutes in direct sunlight. When the picture is particularly bright colored, only one or two minutes are necessary; but if, instead of a wide-angle lens, a rapid rectilinear lens is used, it is possible, with a brilliant light, to reduce the exposure to less than a minute.

A curious fact observed was that the plates were relatively much less sensitive in a weak light than with bright sunlight, so much so as to require at least twenty times more exposure where the proportion in an ordinary rapid gelatine plate would not be more than four or five times.

Speaking of the emulsion, he says: "The most sensitive plates are prepared with a fresh chlorophyl solution, which has been made up with alcohol tinted with eosine. But no eosine should be used in making up chlorophyl solutions which are to be kept more than a week, because an *old* chlorophyl solution gives more accurate photographs when it contains no eosine."

Regarding some of his recent experiments, he continues: "Lately

I have had some emulsion which would not work clear except when the tea organifier was used with it. I would therefore advise any who experiment with the process to use the tea organifier, not only because it increases the sensitiveness to light, but because it may insure better results.'

"It is probable that the line of experiments commenced by Mr. Ives may be followed up by some other interested experimentalist, who may discover a way of making color-sensitive plates which will retain their sensitiveness, similar to the ordinary gelatine dry plate, for any length of time."

FROM THE PHILADELPHIA LEDGER, DEC. 11, 1885.

. . . "Mr. Ives, of this city, has obtained remarkably accurate tone values in photographs of colored objects. Dr. Vogel, of Germany, and other European photographers, have similar processes, but Mr. Ives is an original inventor, and has succeeded better than any others in this particular field of photography. The difficulty with the process is that the time required for the exposure is greatly increased. This is not a matter of much importance when copies of paintings or colored prints are to be made, or when a photograph is desired of a landscape from nature without moving objects; but it makes portraiture from the living subject, by the new process difficult, if not impossible."

FROM THE BRITISH JOURNAL OF PHOTOGRAPHY, JAN. 22, 1886.

. . . "So far as we are aware, very little has been done, practically, in this country with staining the sensitive film. . . — In America, Mr. F. Ives has worked very successfully with chlorophyl, and some of the results that gentleman has forwarded to us clearly demonstrate its value in rendering color in its true relation. On the Continent, we have Dr. Vogel working with some of the eosines, and, latterly, with "azaline;" Lohse with turmeric, Tailfer with eosine in gelatine, etc."

THE DISPUTE ABOUT PRIORITY.

A STATEMENT BY THE AUTHOR.

In 1884, more than four years after I published my original method of photographing all colors in the true proportion of their brightness, and several months after I perfected my claim by the publication of additional facts and experiments, Dr. H. W. Vogel announced that he had invented such a method, with eosine as the color-sensitizer. He also asserted that his method was the result of eleven years of patient experiment, that it was the first practical solution of this problem, and that no other similar method had been published. I then called attention to my own earlier publications, and to the fact that my method with chlorophyl would give better results than Dr. Vogel's method with eosine. Dr. Vogel followed with a communication to the *Photographic News*, denying the truth of my assertions, as follows:

DR. VOGEL'S LETTER.

"In the *Year Book of Photography* for 1885, page 111, I find an interesting article of Mr. Ives, Philadelphia, on his isochromatic process with chlorophyl. In this article Mr. Ives mentions also my researches in the matter, and says:—'Dr. Vogel was undoubtedly the first to suggest the use of dyes for increasing the color sensitiveness of silver bromide; but he was not the first by several years to publish a practical, useful process,' etc., etc. I beg to remark as to this assertion of Mr. Ives that, eleven years ago, I did not confine myself to make only suggestions or spectrum photographs, but that I showed by experiment, already described in my first paper, published in the *Photographische Mittheilungen*, 1873, and in the *Photographic News*, 1874, that my new process of making bromide of silver sensitive to the so-called non-actinic rays was of real practical value. I reproduce here the lines in question from my paper of 1873:—'I took a picture of a blue ribbon on a yellow ground. With an ordinary bromo-iodized plate I got a white ribbon on a dark ground. On a bromide of silver plate, stained with coraline, I could not hope to get anything, because blue and yellow rays acted on this plate with the same energy. Therefore, I put in front of the lens a yellow glass, which let pass the yellow rays, but absorbed the blue ones, and I now obtained with sufficient exposure a dark ribbon on a light ground.'

"I think this picture taken in 1873, in the described manner, was the first isochromatic photograph taken. It may be possible that chlorophyl (first proposed by Becquerel, 1875, for increasing the sensitiveness of bromide of silver for red rays,) may give better results than coraline. But surely, the chlorophyl process is *not* the first isochromatic process?

"Even the *modus operandii* of Mr. Ives is not new. Mr. Ives soaks bromide of silver plates in chlorophyl solution. Exactly the same method of preparation I employed in 1876 (*Photographische Mittheilungen*, xii, page 286), and I recommended it for all dyes which are affected by free acid in collodion."

I replied at length to the above, but the following brief statement of facts covers the main points:

1. The claim that he regarded the coraline process as "of real practical value" is met by his own contrary statement, in the *Photographic News*, March 28, 1884, page 195, that his early experiments "were of merely scientific value for spectrum analysis," etc., etc. That it *has no practical value* is proved by his admission that coraline plates are about *eight times less color-sensitive than eosine plates, and not sensitive to red.*

2. I never claimed to have published "the first isochromatic process," but only to have published the first practically useful one, and *the first method of photographing all colors correctly.*

3. Dr. Vogel did not use blue-myrtle chlorophyl, did not say that he had ever exposed any kind of a chlorophyl-stained plate through a color-screen, did not say, and did not know or believe, that it would be possible in any way to obtain correct-color-tone photographs by the aid of chlorophyl. So far from having discovered the capabilities of chlorophyl, his references to it were calculated to produce the impression that, so far as he knew, it was not even much better than coraline, and was worthy of no comparison with eosine!

After the appearance of my article in the Journal of the Franklin Institute, May, 1885, Dr. Vogel wrote other letters attacking me and my claims. Under pretence of correcting mistakes, which he falsely accused me of making, and by emphasizing the fact that one of my incidental remarks which was substantially correct was not *exactly* so, he tried to cast discredit on my claims by producing an impression that I was ignorant of the subject, and of what had been done by others; he not only tried to make it appear that I said what I did not, but at last he took refuge (?) in a positive denial that he had ever spoken or published certain significant statements which appeared over his signature in the British photographic journals.

My only object in calling attention to these facts is to protect my reputation for veracity, which Dr. Vogel appeared to be trying to make a show of breaking down. The letters referred to, and my replies to the same, may be found as follows:

DR. H. W. VOGEL.	F. E. IVES.
Phila. Photog'r, July, 1885, p. 204.	Phila. Photog'r, Sept., 1885, p. 304.
" " Nov., " p. 364.	" " Dec., 1885, p. 384.
	Photo. Times, Nov. 13, 1885, p. 644.
Photo. Times, Jan. 15, 1886, p. 42.	" " Feb. 5, 1886, p. 87.